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Utilization of Puzzle-8 Educational Game Learning using the Stepest Ascent Hill Climbing Algorithm

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Abstract

Learning through educational games is increasingly becoming the main focus in the world of modern education. This research examines the use of puzzle-based educational games, especially Puzzle-8, as an interactive learning medium. In order to increase learning effectiveness, this research implements the Steepest Ascent Hill Climbing Algorithm as a method for solving puzzles and obtaining optimal solutions. The research methodology includes algorithm implementation steps in the context of Puzzle-8, with the aim of increasing players' understanding of the concepts of logic, strategy and solution to problem. In addition, experiments were carried out using datasets from players participating in the game to evaluate algorithm performance and learning effectiveness. The experimental results show that the use of the Steepest Ascent Hill Climbing Algorithm in the Puzzle-8 learning context can provide a deeper learning experience and improve players' ability to design strategies and develop problem solving skills. Statistical analysis regarding the convergence time and success of the optimal solution provides an overview of the efficiency of the algorithm in a learning context. This research contributes to our understanding of the potential of the Steepest Ascent Hill Climbing Algorithm as a learning tool in educational games, especially in Puzzle-8. The implications of this research finding can be used as a basis for further development in the design of educational games that focus on developing critical thinking and problem solving skills at different educational levels.

Keywords; Educational Game, Searching, Puzzle-8, Stepest Ascent Hill Climbing Algorithm

1. Introduction

In the era of information technology development, innovative approaches to learning are the key to increasing the effectiveness of the educational process. One approach that is becoming increasingly popular is the use of educational games as an interactive and engaging learning tool. In this context, Puzzle-8, a classic puzzle game with high educational potential, appears as an interesting alternative to introduce the concepts of strategy, logic and problem solving to students. This research focuses on exploring the use of the Puzzle-8 Educational Learning Game. , with a focus on implementing the Steepest Ascent Hill Climbing Algorithm as a learning instrument. This algorithm, which is generally used in solving optimization problems, has the potential to improve critical and strategic thinking skills through the player's interaction with the movement steps it produces. In this context, this research aims to evaluate the extent to which the Steepest Ascent Hill Climbing Algorithm can enrich learning experience through Puzzle-8. By understanding the effectiveness of this algorithm in a learning context, we can identify the potential of the educational game Puzzle-8 as an innovative learning tool.

Descriptively, there was an increase in number ability after implementing the puzzle game, with medium ability category (N-gain = 0.59). Furthermore, inferentially, tcount = 4.03 and ttable = 2.95. Thus, tcount > ttable, meaning that there is an increase in children's ability to number after implementing the puzzle game.[1]

The impact of this edugame learning media is that the learning media influences students' thinking abilities. The research instruments used were questionnaire and observation guidelines. Based on the results of data analysis, validation results were obtained from media experts with an average score of 73.649% in the appropriate criteria, while the average response from users was 80.335% in the attractive criteria.[2]

Educational games are games that are very popular with preschool children nowadays in carrying out their activities because basically playing this game uses the term play while learning, this game is very useful in developing the brain of preschool children to increase thinking data in sharpening the brain. , this game consists of 8 sequences of non-sequential numbers arranged into sequential numbers to form Puzzle -8 which is guided by the concept of rules in algorithms. The problem in this case is the child's lack of interest in learning to count and arrange numbers because they are difficult to understand. With learning games, this research aims to help young children calculate number sequences which are usually difficult to understand. With this game, it can be used as a gaming arena but contains elements of learning and putting together the number 8 puzzle. The method used uses the Ascent Hill Climbing Algorithm, where the work process of

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this algorithm can produce a sequence of regular numbers using the concept of shifting number values according to existing rules. [3]

Arranging numbers using Puzzle 8 is a game that is very popular with children at the moment. This educational game has very broad benefits, usually for improving memory and thinking patterns. The 8 Puzzle Game Algorithm must have a clear process of stages in order to achieve a goal in the Search system. 8 puzzle game logic using the Ascent Hill Climbing algorithm is often used in artificial intelligence. The problem that occurred in the research was children's lack of understanding in finding a suitable algorithm to arrange the 8 Puzzle game according to the principles of how an algorithm works. The 8 puzzle arrangement game must follow predetermined rules in order to obtain the correct algorithm so as to produce an arrangement that matches the initial data. The benefit of this research is providing a solution to solve the 8 puzzle game according to the rules of the Ascent Hill Climbing Search Algorithm, thus producing a solution in the search method.[4]

Artificial intelligence is a part of science that really helps human work in everyday life. Artificial intelligence has a broad scope so that artificial intelligence can be implemented in various branches of science, for example the ancient Roman letter recognition game. This game completes the game in the form of arranging ancient Roman letters sequentially according to the Ascent Hill Climbing Algorithm concept. The problem with this game is that errors often occur in arranging the order of the Roman letters so it is difficult to complete this puzzle game. The aim of this research is to make it easier for puzzle game players to complete the Roman letter number arrangement game according to the rules of the Ascent Hill Climbing algorithm. The Ascent hill Climbing algorithm carries out the process of searching for the highest value to find the final solution. The working system of this algorithm uses a heuristic function. The process of completing this research consists of 9 cities with the working principle of changing the position of the boxes into the correct sequence of ancient Roman letters according to the final state of the puzzle. There are 4 rules that must be followed to get the final solution, namely by changing the position of the puzzle to the right position, to the left position, the top position and the bottom position until the puzzle position is correct according to the sequence and final state.[5]

Artificial intelligence is experiencing rapid development in the world of computers or robots. Artificial intelligence in computers is used to make decisions like humans and can run automatically to help human life. One of the algorithms used is A-Star to search for the closest path from a given starting point to a destination point consisting of one or several destinations. In this paper, the A-Star algorithm is used to determine the closest path search sequence with a distance function and is applied to a 3D human object running in a game environment with 1600 square grid paths. So that 3D objects move automatically and can avoid obstacles, the repulsive field method is used. The results of the test obtained the shortest cost value of 250 with a path length of 23, the shortest computing time of 8.00 ms with a path of 61, human 3D objects can find the closest path to the goal and are able to avoid existing obstacles [.6]

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The data collection method is by browsing the internet, studying books, journals, theses, and the SWOT analysis system. The random shuffle algorithm for randomizing puzzles and game agents uses the FSM (finite state machine) control system as AI (artificial intelligence). UML (unified modeling language) method. The results of this research are game applications for recognizing the names of fruit, animals and transportation in the form of .APK and run on Android smartphones, educational games "puzzle games".[8]

Based on research conducted at the North Payakumbuh Pembina Kindergarten, descriptively there was an increase in number ability after implementing the puzzle game, with the medium ability category (N-gain = 0.59). Furthermore, inferentially, tcount = 4.03 and ttable = 2.95. Thus, tcount > ttable, meaning that there is an increase in children's ability to number after implementing the puzzle game.[9]

The 8th puzzle putting together game is part of the quest. Puzzle 8 is an implementation of the steepest hill climbing algorithm by following established rules. The working process of this algorithm is to look at the initial position of the puzzle arrangement. After the process is carried out, you can see whether the shift results are close to the correct arrangement position. [10]

The problem that often occurs is a lack of knowledge in solving game cases quickly so that it takes a long time to get the final state. The main aim of this research is to provide information to make it easier to solve puzzle game cases using an algorithm. The final

result is in the form of arranging a puzzle that complies with the rules using an algorithm concept so that a decision-making system is obtained to complete the puzzle game correctly. [11]

Artificial intelligence is a part of science that really helps human work in everyday life. Artificial intelligence has a broad scope so that artificial intelligence can be implemented in various branches of science, for example the ancient Roman letter recognition game. This game completes the game in the form of arranging ancient Roman letters sequentially according to the Ascent Hill Climbing Algorithm concept. The problem with this game is that errors often occur in arranging the order of the Roman letters so it is difficult to complete this puzzle game. The aim of this research is to make it easier for puzzle game players to complete the Roman letter number arrangement game according to the rules of the Ascent Hill Climbing algorithm.[12]

The alphabetical arrangement game is a game that is often used by preschool children who are just learning to recognize the arrangement of letters. This game is really enjoyed by preschool children because this game requires concentration and contains interesting elements so that they are interested in completing the game structure according to the order. This game is very useful for increasing the speed of thinking and eye patterns and improving children's skills. The main aim of this research is to provide information to easily solve alphabetic puzzle game cases using an algorithm. The final result is an alphabetical puzzle arrangement that complies with the rules using an algorithm concept so as to obtain a decision-making system to solve the alphabetic puzzle game correctly.[13]

Arranging numbers using Puzzle 8 is a game that is very popular with children at the moment. This educational game has very broad benefits, usually for improving memory and thinking patterns. The 8 Puzzle Game Algorithm must have a clear process of stages in order to achieve a goal in the Search system. 8 puzzle game logic using the Ascent Hill Climbing algorithm is often used in artificial intelligence. The problem that occurred in the research was children's lack of understanding in finding a suitable algorithm to arrange the 8 Puzzle game according to the principles of how an algorithm works. The 8 puzzle arrangement game must follow predetermined rules in order to obtain the correct algorithm so as to produce an arrangement that matches the initial data. The benefit of this research is providing a solution to solve the 8 puzzle game according to the rules of the Ascent Hill Climbing Search Algorithm, thus producing a solution in the search method. Based on the search process, the final result of the puzzle game meets the correct position of the 8 boxes according to the initial rule, so the search is stopped and produces a goal.[14]

Puzzle playing is a game that shifts numbers from a box consisting of nine boxes. Eight boxes must have values arranged in numerical order starting from numbers 1 to 8. Puzzle games can produce the correct sequence according to the initial conditions provided they follow the rules. established rules. Completion of this game uses a heuristic method, using the Ascent hill Climbing algorithm. The work process of the Ascent Hill Climbing method is a process of looking for several possible solution options in order to get the optimal value to solve the problem by arranging the values from the position of the smallest value to the position of the largest value. The problem that is often experienced in this case is the user's lack of knowledge in the concept of puzzle game rules so that search results are difficult to find. This method can make it easier to solve puzzle game cases by following the game rules and doing it systematically so that the goal is found quickly. The goal results obtained are in the form of steps in the process of finding a solution and calculating the time required in the search to find a solution.[15]

The main aim of this research is to help children improve their thinking patterns so they can arrange the numbers 1 to 8 with time and quickly with solutions. The method used is the Best First Search algorithm to search for the Final Goal quickly and easily. The final result of this research after carrying out several stages of eating was that the final result was that the puzzle sequence had met the final goal in accordance with the initial data. The basic concept of completing the Best First Search Algorithm must follow the rules that have been set by carrying out the process according to existing procedures. If during the search process an inappropriate arrangement is found, the search will continue until the correct position is found in the form of a sequence of numbers 1 to 8. If this is found, the algorithm search will be stopped.[16]

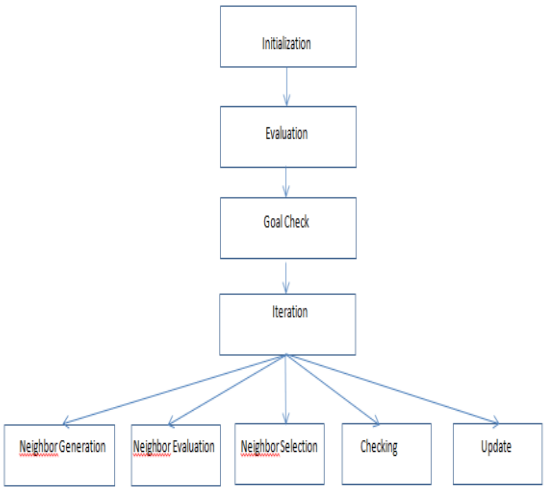
Search is the process of looking for a solution to a problem until a solution or goal is found, or movement in state space to find a path from the initial state to the goal state. In the game TIC TAC Toe the process of finding spatial situations is not enough to automate problem solving behavior, in each of these situations there are only a limited number of choices that can be taken by the player. The problems that will be faced can be solved by searching from the existing options, supported by the usual solution methods. Best First Search works by searching a directed graph in which each node represents a point in the problem space.[17]

The critical path is something that is very important and needs to be considered in project scheduling,

because the critical path has an impact on whether a project is late or not. There has been an increase in project growth rates in Indonesia. Therefore, to support the success of the project, research was carried out on the search for critical paths. So that the results of this research will be useful for developers who want to create applications that implement critical path search. The parameters of this algorithm are time, namely: Earliest Start (ES), Early Finish (EF), Last Start (LS), and Last Finish (LF). The Steepest-ascent Hill Climbing algorithm is useful for finding goals based on the best heuristic values. The best heuristic value used as a reference is the slack time of the activity.[18]

2. Research methodology

The Steepest Ascent Hill Climbing algorithm is a local optimization algorithm used to find the best solution in the search space. The following are the stages of the Steepest Ascent Hill Climbing algorithm and their charts:



Picture 1. Steepest Ascent Hill Climbing Algorithm Stages

The following is a description of the image above:

1.Initialization:
Start with an initial solution generated randomly or through user input.

2.Evaluation:
Calculate the functionality value (fitness value) of the initial solution.

3.Aim Check:
Check whether the initial solution meets the goal criteria or stop criteria. If yes, stop, because the current solution is considered the optimal solution.

4.Iteration:
As long as the stop criteria have not been met:

a. Neighbor Generation:
Generate all possible neighboring solutions of the current solution. This could involve changing one element to the current solution.

b. Neighbor Evaluation:
Calculate the functionality value for each resulting neighbor solution.

c . Neighbor Selection:
Select the neighboring solution that has the best (closest to optimal) functionality value of the current solution.

d. Checking:
Check whether the best neighbor solution provides improvements compared to the current solution.

e. Update :
If the best neighbor solution provides an improvement, use that neighbor solution as the current solution.

Once the stopping criterion is met, the current solution is considered the optimal or closest to optimal solution in the context of the given evaluation function.

A flowchart or flowchart for this algorithm can describe these steps in a clearer form. However, keep in mind that the Steepest Ascent Hill Climbing Algorithm does not guarantee a globally optimal solution and can get stuck in local minima. Therefore, this method needs to be applied with caution depending on the nature of the problem at hand.

3. Results and Discussion

1. The basic rule that must be followed is to move the empty box to the top of the puzzle where if x>1 then (x-1,y)

2. The basic rule that must be followed is to move the empty box down Puzzle if x<3 then (x+1,y)

3. The basic rule that must be followed is to move the empty box to the right Puzzle if x<3 then (x+1,y)
4. The basic rule that must be followed is to move the empty box to the left. Puzzle if x>1 then (x,y>1).

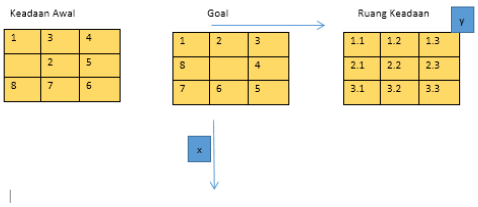


Figure 2. Move the Empty Box Down

1. Iteration 1

Check Initial Condition = Goal
Current state = Initial state
The current situation is known to 4 operators at once, the result is:

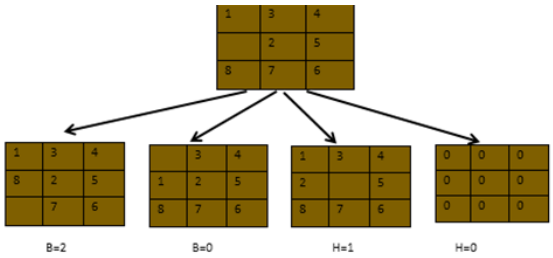


Figure 3. Initial Condition

2. Iteration 1

Check Initial Condition = Goal
Current state = Initial state
The current situation is known to 4 operators at once, the result is:

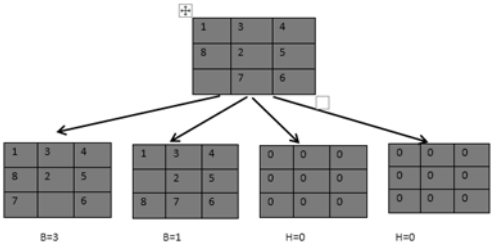


Figure 4. Move the Empty Box Down

3. Iteration 1
Check Initial Condition = Goal
Current state = Initial state
The current situation is known to 4 operators at once, the result is:

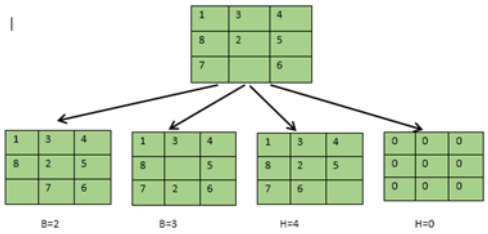


Figure 5. Initial State

4. Iteration 1
Check Initial Condition = Goal
Current state = Initial state
The current situation is known to 4 operators at once, the result is

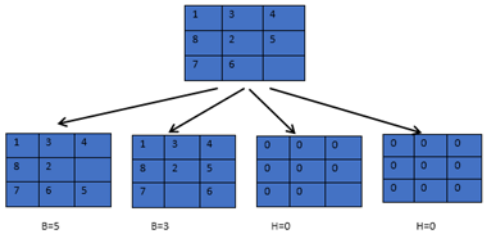


Figure 6. Current situation

Check Initial Condition = Goal
Current state = Initial state
The current situation is known to be 4 operators

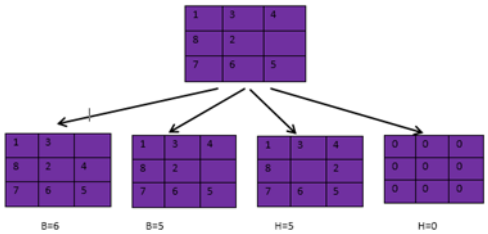


Figure 7. Current situation

5. Iteration 1
Check Initial Condition = Goal
Current state = Initial state
The current situation is that 4 operators are known at once , the results are :

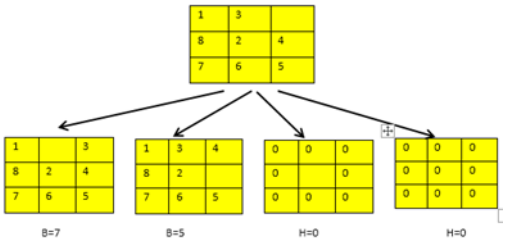


Figure 8. Current situation

6. Iteration 1
Check Initial Condition = Goal
Current state = Initial state
The current situation is known to 4 operators at once, the result is:

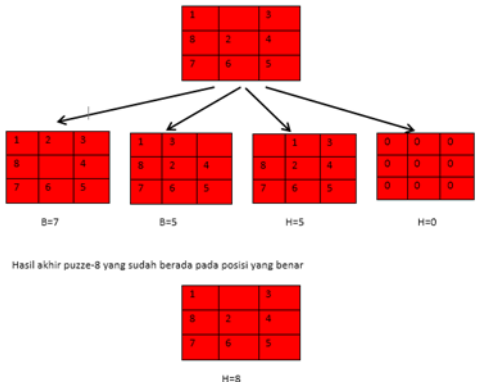


Figure 9. Current situation

To see the correct position of the values, an equation process is carried out. The values used to see the correct position are the values 1 and 0.

a) Number 1 explains the position of the correct value box
b) The value 0 explains the position of the box with the value False

Iteration Process

7. Iteration 1

Check Initial Condition = Goal
Current state = Initial state
The current situation is known to 4 operators at once, the result is:

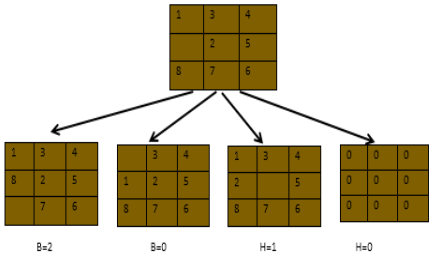


Figure 10. Initial State

8. Iteration 1

Check Initial Condition = Goal
Current state = Initial state
The current situation is known to 4 operators at once, the result is:

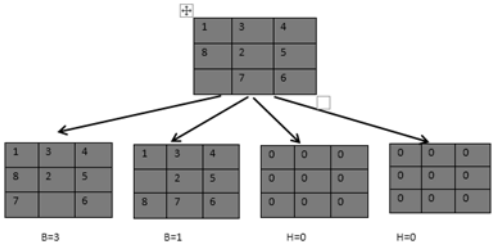


Figure 11. Move the Empty Box Down

9. Iteration 1
Check Initial Condition = Goal
Current state = Initial state
The current situation is known to 4 operators at once, the result is:

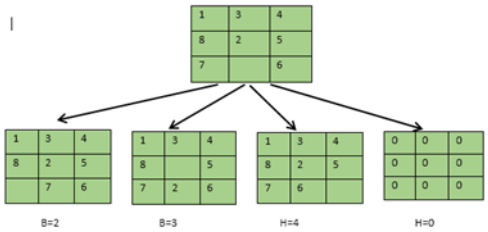


Figure 12. Initial State

10. Iteration 1
Check Initial Condition = Goal
Current state = Initial state
The current situation is known to 4 operators at once, the result is

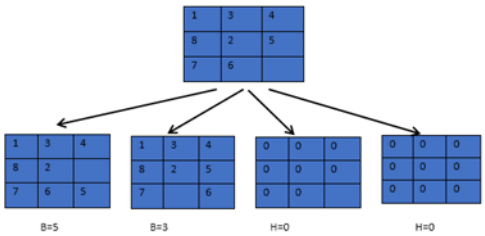


Figure 13. Current situation

11. Iteration 1
Check Initial Condition = Goal
Current state = Initial state
The current situation is known to be 4 operators

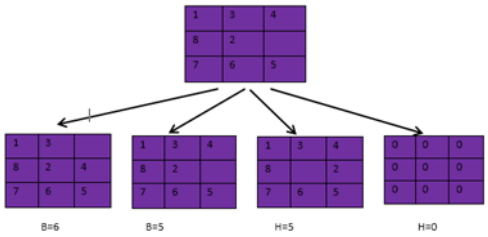


Figure 14. Current situation

12. Iteration 1
Check Initial Condition = Goal
Current state = Initial state
The current situation is that 4 operators are known at once , the results are :

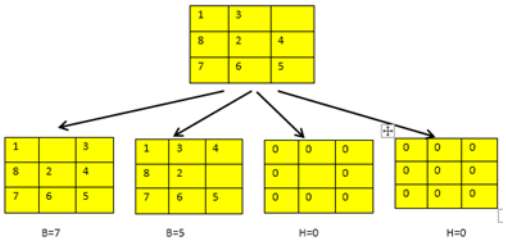


Figure 15. Current situation

13. Iteration 1
Check Initial Condition = Goal
Current state = Initial state
The current situation is known to 4 operators at once, the result is:

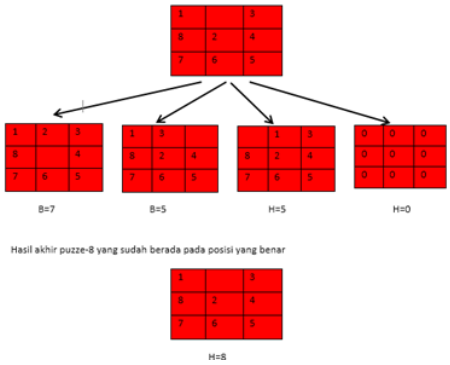


Figure 16. Current situation

To see the correct position of the values, an equation process is carried out. The values used to see the correct position are the values 1 and 0.

a. Number 1 explains the position of the correct value box
b. The value 0 explains the position of the box with the value False

Iteration Process

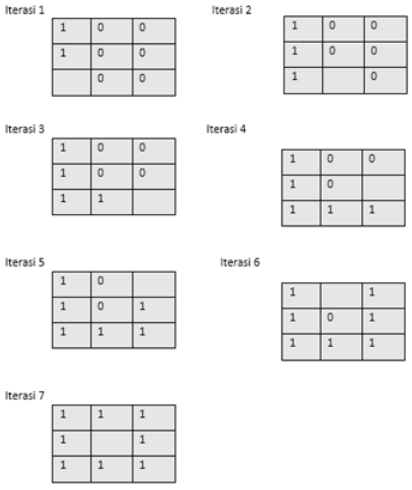


Figure 17. Iteration Process

Comparison results can be seen in the table below

Table 1. Iteration Table

No	Iteration Process	Amount
1	1+0+0+0+0+0+0	1
2	1+0+0+1+0+0+0	2
3	1+0+0+1+0+0+1+0	3
4	1+0+0+1+0+0+1+1	4
5	1+0+0+1+0+1+1+1	5
6	1+0+1+0+1+1+1+1	6
7	1+1+1+0+1+1+1+1	7
8	1+1+1+1+1+1+1+1	8

Based on the table above, it can be concluded that the process of solving the educational game Puzzle-8 gets the correct position of 8 numbers through a step-by-step iteration process. Each iteration process carried out will produce 1 value which will be the correct value, so it can be interpreted that if the more iteration processes are carried out, the greater the output that will be obtained to obtain the final state.

4 .Conclusion

In order to increase the effectiveness of learning through educational games, this research succeeded in implementing the Steepest Ascent Hill Climbing Algorithm in the context of the Puzzle-8 game. The experimental results show that the use of this algorithm has a positive impact on the player's learning experience. Players not only develop logic and critical thinking skills, but also gain a deeper understanding of strategy and problem-solving concepts. With algorithm efficiency analysis showing efficient convergence times, this research confirms the practicality of the algorithm in providing optimal solutions at a level accessible to players. In addition, the interactions resulting from the use of the Steepest Ascent Hill Climbing Algorithm add dimension to the learning experience, motivating players to be actively involved in the learning process. The implications of this research finding open the door for further developments in puzzle-based educational game design, offering an innovative approach to improving problem-solving and critical thinking skills at various educational levels. Thus, the integration of the Steepest Ascent Hill Climbing Algorithm in Puzzle-8 learning marks a positive step towards the development of an engaging, interactive and meaningful learning method.

References

[1] N . Nari, Y. Akmay, and D. Sasmita, "Application of puzzle games to improve numeracy skills," *J. Pembang. Educator. Foundations and Apps.* , vol. 7, no. 1, pp. 44–52, 2020, doi: https://doi.org/10.21831/jppfa.v7i1.26499

[2] BO Aini, KC Ayu, and S. Siswati, "Development of a puzzle game as an Android-based educational game to improve elementary students' mathematical thinking abilities," *JTAM | J. Theor. and App. Matt.* , vol. 3, no. 1, p. 74, 2019, doi: https://doi.org/10.31764/jtam.v3i1.768

[3] PMP M, "Educational Game for Learning to Count Number Arrangements in Puzzle-8 Using the Steepest Ascent Hill Climbing Method," *Build. Informatics, Technol. Sci.* , vol. 3, no. 3, pp. 148–154, Dec. 2021, doi: https://doi.org/10.47065/bits.v3i3.1015

[4] MFM Sari, "Application of the Ascent Hill Climbing Algorithm in the Educational Game of Arranging Puzzle-8 Number Series," *J. Sist. Comput. and Inform.* , vol. 3, no. 2, p. 141, Dec. 2021, doi: https://doi.org/10.30865/json.v3i2.3612

[5] J. Implementation, K. Artificial, V. Karnadi, A. Teknik, A. Karya, and S. Full, "Artificial Intelligence in Roman Numeral Educational Games Using the Steepest-Ascent Hill Climbing Method," vol. 4, no. 2, pp. 164–172.

[6] AA-S. Sake, "Implementation of Artificial Intelligence Using Algorithms," no. October 2021, p. 1–9, 2021 BRAHMANA: Journal of the Application of Artificial Intelligence Accredited Number 204/E/KPT/2022 | Vol. 4, no. 2, June (2023), pp. 164-172 172 , doi: https://doi.org/10.31219/osf.io/r29q4

[7] BO Aini, KC Ayu, and S. Siswati, "Development of a puzzle game as an Android-based educational game to improve elementary students' mathematical thinking abilities," JTAM | Journal of Mathematical Theory and Applications, vol. 3, no. 1, p. 74, 2019, doi: https://doi.org/10.31764/jtam.v3i1.768

[8] M. Kania, "Puzzle Educational Game Application Using Artificial Intelligence Based on Android," Scientific Journal of Computer Science, vol. 7, no. 2, p. 62–69, 2021, doi: https://doi.org/10.35329/jiik.v7i2.205

[9] N. Nari, Y. Akmay, and D. Sasmita, "Application of puzzle games to improve numeracy skills," Journal of Educational Development: Foundations and Applications, vol. 7, no. 1, p. 44–52, 2020, doi: https://doi.org/10.21831/jppfa.v7i1.26499

[10] S. Silvilestari, "Steepest Ascent hill Climbing Algorithm To Solve Cases In Puzzle Game 8," IJISTECH (International Journal of Information Systems and Technology), vol. 5, no. 4, p. 366, 2021, doi: https://doi.org/10.30645/ijistech.v5i4.153

[11] Y. Yendrizal, "Application of Artificial Intelligence on Puzzle-8 Using Steepest Ascent hill Climbing Algorithm," IJISTECH (International Journal of Information Systems…, vol. 6, no. 158, pp. 17–24, 2022. https://doi.org/10.30645/ijistech.v6i1.208

[12] Rika Widya Perdana, "Edik Informatics Journal Edik Informatics Journal," Research in the Field of Computer Science and Informatics Education, vol. 6, no. 1, p. 9–18, 2022.

[13] S. Novia, "Siteba Journal," Alphabet Puzzle Game Using the Ascent Hill Climbing Algorithm, vol. 1, no. 1, p. 14–22, 2022.

[14] MFM Sari, "Application of the Ascent Hill Climbing Algorithm in the Educational Game of Arranging Puzzle-8 Number Series," Journal of Computer Systems and Informatics (JSON), vol. 3, no. 2, p. 141, 2021, doi: https://doi.org/10.30865/json.v3i2.3612

[15] Y. Afero, "Artificial Intelligence Application of the Ascent Hill Climbing Algorithm in the Puzzle 8 Game," Elkom: Journal of Electronics and Computers, vol. 14, no. 2, p. 325–331, 2021, doi: https://doi.org/10.51903/elkom.v14i2.508

[16] Y. Mardiansyah and SN Rizki, "Implementation of Ascent Hill Climbing Algorithm Problem Solving in Puzzle-8," vol. 6, p. 583–590, 2022

[17] Harvei Desmon Hutahaean, Volume 2 No. 1, June 2017, Application of the Best First Search Method in the Tic Tac Toe Game https://doi.org/10.54367/means.v2i1.14

[18] Elvina, Lukman, 2018 Modification of the Steepest-Ascent Hill Climbing and Backtracking Algorithm for Project Critical Path Search, Cogito Smart Journal | VOL. 4 | NO.2, https://doi.org/10.31154/cogito.v4i2.133.268-282